

If you can afford the space I shall be glad to add a few words to the recent communications of Major Lang and Mr. Hughes to NATURE on the occurrence of *Antedon rosaceus* in Torbay.

I do not think *Antedon* has been more abundant than usual during the present year in this locality. An entry in an old note-book reminds me that a chance haul near the Thatcher Rock on July 11, 1871, brought up "plenty of feather stars," and since then during the six years I have dredged in Torbay, *Antedon* has been a very ordinary capture whilst dredging for other objects of interest.

The haul under Berry Head on July 25, alluded to by Major Lang, was undoubtedly an unusually prolific one, but had it not been for the fortunate discovery by Major Lang of the pedunculate form, the mere occurrence of an abundance of the adult feather stars would have made no impression on my mind and no notice would have been taken of it.

Remembering that the Birmingham Natural History Society had taken the young, I mentioned the fact to Major Lang, adding that I had never seen them myself. Next morning I was gratified to hear that on examining at his leisure the proceeds of the haul he had found them in quantity.

This successful result induced me to revisit the spot near the Thatcher after an interval of six years, and there, as I fully expected, *Antedon*, both adult and immature, was abundant. With this experience to guide me, I have since tried a third locality, when, though the adults were less numerous, the pedunculate young, and every stage of growth up to about an inch in diameter, appeared to me to be even more numerous than at Berry Head or the Thatcher.

In conclusion, I beg to say that it will give me pleasure to afford the fullest information in my power to any naturalist desirous of dredging in Torbay. It has often been a source of regret to me to see strangers wasting their time in dredging in spots where, as my old boatman used to say, they could not expect to meet with anything "of any consequence."

ARTHUR ROOPE HUNT

Southwood, Torquay, November 6

As the localities of *Antedon rosaceus* seem to be exciting interest, I may notice that I dredged the adult state in June, 1875, in Bressay Sound, sheltered in about 10 fathoms water, and in June, 1876, abundantly between Mount St. Edgecumbe and Duke Island, Plymouth, in about the same depth of water, in each case on a rocky bottom.

PHILIP B. MASON

Burton-on-Trent, November 8

Meteor

On November 6 I observed a large meteor of a red colour. It commenced near the zenith and took a sinuous course about west-south-west, dividing into two portions after it had travelled about 40°, one portion disappearing about 10° above the horizon nearly due west, the other taking a north-west direction, and disappearing somewhat higher; it was not very bright, but seemed to be a large one. I should like to hear if anyone else has seen it; the time was between 8 and 9 P.M.

Clithero, Lancashire

T. NOSTRO

THE MUSICAL ASSOCIATION¹

THE third annual session of this Society opened on Monday, November 6, with a paper of considerable interest from Alexander J. Ellis, Esq., F.R.S., "On the Sensitiveness of the Human Ear for Pitch and Change of Pitch of Notes in Music."

It appears from the Annual Report, just issued, that the Association numbers 170 members, and is in a sound financial position. It may therefore be considered to have passed its period of infancy, and should now be permanently reckoned among the learned confederations of the metropolis.

It is not altogether uninteresting to look back at its origin and to point out the fulfilment of the especial objects for which it was established.

The first conception appears to have emanated from Mr. William Spottiswoode, Dr. Stainer, and a few other

¹ Report and Proceedings of the Musical Association for 1874-5 and 1875-6.

gentlemen, representing about equally the scientific and artistic sides of music, who circulated a letter among their friends, and in a private meeting held at the house of the Treasurer of the Royal Society, laid the foundations of its future organisation. The original title chosen for the new society explained at more length its peculiar objects than that which it now bears; it was "Society for the Investigation and Discussion of Subjects connected with the Art and Science of Music."

The double function herein indicated has hitherto been steadily and rigorously carried out. Indeed the Council for 1876-7, numbering among its members eminent musicians such as the two professors of Oxford and Cambridge, Messrs. Hullah, Osborne, Goldschmidt, and Dr. Stainer, is supplemented on the side of Science and Literature by the familiar names of Mr. Spottiswoode, Prof. Tyndall, Dr. Pole, Mr. W. Chappell, and Mr. George Grove.

The contributions recorded in the two annual volumes of "Proceedings" are strictly in concordance with the initial programme; they cannot be better summed up than in the words of Mr. Spottiswoode's letter above-named, advocating "the formation of a society similar in the main features of its organisation to existing learned societies. Its periodical meetings might be devoted partly to the reading of papers upon the history, the principles, and the criticism of music, partly to the illustration of such papers by actual performance, and partly to the exhibition and discussion of experiments relating to theory and construction of musical instruments, or to the principles and combination of musical sounds."

In the first year Mr. Hullah, Dr. Stainer, and Mr. Sedley Taylor, spoke on musical notation and nomenclature; Mr. Bosanquet and Mr. Ellis furnished valuable illustrations of true and tempered intonation; Mr. Charles E. Stephens criticised Dr. Day's theory of harmony; Mr. Baillie Hamilton and the writer described their respective improvements in musical instruments.

During the second session there were two papers of great value, mainly historical, from Sir F. Ouseley, "On the History of Ecclesiastical Music in Western Europe;" and from Prof. W. G. Adams "On Wheatstone's Musical Inventions," two "On Notation," by Dr. Pole and Prof. Monk; two mathematical and physiological, by Lord Rayleigh, "On Our Perception of the Direction of a Source of Sound," and Mr. Lennox Browne "On the Management of the Voice;" two mechanical and instrumental, by Mr. de Pontigny, "On Kettledrums," and by the writer "On Standards of Musical Pitch;" one critical, perhaps even polemical, by the active secretary of the Association, Mr. C. K. Salaman, "On Musical Criticism."

Several of the above communications, especially Mr. Bosanquet's two exhaustive papers "On Temperament," call for full analysis; but the general status and purpose of the Association itself are so far novel as to deserve preliminary attention. Music, of all æsthetical subjects, is that which is most deeply marked by its bisection into art and science; much of the art, little of the science is ancient; for Euclid, Pythagoras, and even Galileo carry us only a short distance into the laws of harmony. But it is peculiar to music that instruments accidentally invented, slowly improved, fabricated simply for performance, and intended solely to charm the ear, have at a later period furnished the tools and apparatus of scientific analysis. The violins of Gaspar di Salo and Stradivarius, have for centuries illustrated the laws of harmonic sounds, and even as early as the time of Tartini, furnished the *Terzo Suono*, which figures so boldly in modern acoustics.

As the instruments themselves fulfil a double purpose, so are their votaries divided into two very distinct classes, those namely of artists and theorists. The essential value of Mr. Spottiswoode's proposal lay in the appreciation of this schism, and of the means towards healing it. The

artistic world of music, great as the individual acquirements of some members as executants may be, is essentially a world of handicraftsmen; practising indeed a very subtle art, but led entirely, according to Aristotle's definition, by rules, and not by laws.

The function of the scientific man is to expand these technical rules of art into the conscious and explained laws of science. How nobly this duty has been performed by Chladni, by Savart, by Wheatstone, and above all by Helmholtz, few artists are aware; nor indeed has there been hitherto any easy mode for their obtaining such information. They have been somewhat in the habit of sneering at the theorist as a "mathematician;" nor is it very remarkable that the other party, like the Dublin fishwife whom O'Connell called a parallelopipedon, should retaliate with even more opprobrious epithets. Hence old threadbare jokes about "catgut-scraping," Lord Chesterfield's contempt of musicians, and the like, which culminate in the epigram on Handel and Buononcini. This century is beginning to recognise that varying styles of musical art are not a mere question of "Tweedledum and Tweedledee," and that the "fiddler," though in an utilitarian point of view unnecessary to the maintenance of life, is highly conducive to education and civilisation. If artists are to maintain the improved position of later years it must be by cordially fraternising with the man of science, for thus only can their art hope to acquire the dignity and generalisation which are the prerogatives of *ἐπιστήμη*.

It is to be noticed that this view of the case appears to have been taken by many of our best professional musicians; for the list of members which heads either volume of these "Proceedings" is far more remarkable for individual eminence of the names than for their multitude. It is to be hoped that such a conviction will continue to extend. The number of points in which music is continuous with pure science is considerable, and is daily increasing. Music, moreover, is among the most powerful means we have for cultivating that delicacy of the senses on which all accurate observation depends. It has, as yet, been too apt to fall into the hands of a sect or clique, whose disposition is naturally exclusive, and whose objects have often been the reverse of elevated. But with the great advance which has of late years taken place in general musical knowledge throughout England, and by the fostering care of societies like the present there is ground for anticipation that the science of music may rise to the esteem and consideration as an educator and humaniser which it once held in the writings of Plato, and in the palmiest days of old Greek thought.

W. H. STONE

ON THE RESISTANCE OF THE AIR TO THE MOTION OF PROJECTILES

THE experiments made by Hutton to determine the resistance of the air to the motion of shot were carried out by firing small spherical balls into the receiver of a gun-pendulum. As little confidence could be felt in applying his results to the large service shot at present in use, on the formation of the Advanced Class of Royal Artillery Officers, Woolwich, in 1864, it was thought desirable that a systematic course of experiments should be made with *elongated* shot, and upon a much larger scale. Afterwards, similar experiments were made with *round* shot.

The method of experimenting pursued by Hutton appeared to have been carried to its useful limits, and although a large ballistic pendulum had been constructed for Government, it was practically useless. The chronograph used in the experiments above referred to was invented and constructed for that purpose by the Rev. F. Bashforth, at that time Professor of Applied Mathematics to the Advanced Class, and Official Referee to the Ord-

nance Select Committee. This instrument is now in the Loan Exhibition, South Kensington.

A complete collection of the "Reports on Experiments made with the Bashforth chronograph, 1865-1870" (marked 84, B, 1941), has been published by Government, at the nominal price of one shilling.¹ It will therefore be sufficient here to state that the first set of experiments was made to test the new chronograph, in which the velocity of the shot varied from about 1,150 f.s. to 1,060 f.s. The resistance of the air was found to vary as the *cube* of the velocity. The next experiments were made with *elongated* shot of equal diameters and different forms of head. The velocities here varied from 1,500 f.s. to 1,090 f.s., and the law of resistance still appeared to be the *cubic*. Lastly, a course of experiments was made with *elongated* and *spherical* projectiles (solid and hollow) of 3, 5, 7, and 9 inches in diameter. The velocities of the elongated shot varied from 800 f.s. to 1,750 f.s., and those of the spherical from 800 f.s. to 2,400 f.s. At a given velocity the resistance of the air varied as the square of the diameter. But when the coefficient of resistance was obtained by dividing the numbers expressing the resistances by the cube of the corresponding velocity, the result was not now constant through these great variations of velocity. This coefficient was found to increase rapidly from 900 f.s. up to 1,050 f.s., and from 1,100 f.s. to 1,300 f.s. it was nearly constant, and for higher velocities it gradually decreased with the increase of velocity. The published reports give a full account of every round fired. Unfortunately it has not hitherto been found possible to express the coefficient of resistance by a simple function of the velocity. Mr. Bashforth has made use of the cubic law in his treatise on the motion of projectiles (1873). The trajectory is divided into arcs, and each arc is supposed to be described, while the coefficient of resistance retains its mean value for that arc.

In a tract on the remaining velocities, &c., of several service shot (1871),² Mr. Bashforth stated:—"For ogival-headed elongated shot, the resistance of the air may be said to vary roughly as the *sixth* power of the velocity for velocities 900-1,100 f.s.; to vary as the *third* power for velocities, 1,100-1,350 f.s.; and to vary as the *second* power for velocities above 1,350 f.s."

General Mayevski, Professor of Ballistics to the Academy of Artillery, St. Petersburg, published a work on Ballistics in Russian, in 1870, at the expense of the State. A translation of the more interesting chapters of this work was published in French by the author, in 1872.³ In the preface to the latter work he states that "Les résultats des expériences faites par M. Bashforth en Angleterre sur les projectiles oblongs ont été déduits des données insérées dans les *Proceedings of the Royal Artillery Institution, Woolwich*, 1868. Les expériences de St. Pétersbourg sur la résistance de l'air au mouvement des projectiles sphériques et oblongs ont été faites par nous en 1868 et 1869, et leurs résultats sont pour la première fois publiés dans notre traité. Afin que les expressions de la résistance représentent, avec une approximation suffisante, les résultats de nos expériences et ceux des expériences anglaises, faites avec des appareils perfectionnés, et que ces expressions permettent en même temps une intégration facile, quoique par approximation, des équations différentielles du mouvement, nous avons admis pour les projectiles sphériques, dans les limites des vitesses de 530^{ms} à 376^{ms} (1739-1230 f.s.) la résistance de l'air proportionnelle au carré de la vitesse, et nous avons exprimé, à partir de la vitesse de 376^{ms} (1230 f.s.) jusqu'aux petites vitesses, la résistance de l'air par un binôme dont le premier terme est proportionnel à la deuxième puissance de la vitesse, et le second à la quatrième puissance de la vitesse; pour les projectiles oblongs, quand leur axe de figure coïncide avec la direction du mouvement, nous

¹ W. Clowes and Son; Allen; Mitchell; Longmans and Co.

² London: Spon.

³ Paris: Gauthier-Villars.